PHILIPS

FET PROBE PM9353

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PHILIPS

MANUAL

FET PROBE PM9353

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1. GENERAL INFORMATION

1.1. INTRODUCTION

The FET PROBE PM 9353 is an active probe with unity gain, intended for use with oscilloscopes or other instruments having a 1 MOhm input and a bandwidth up to 150 MHz.

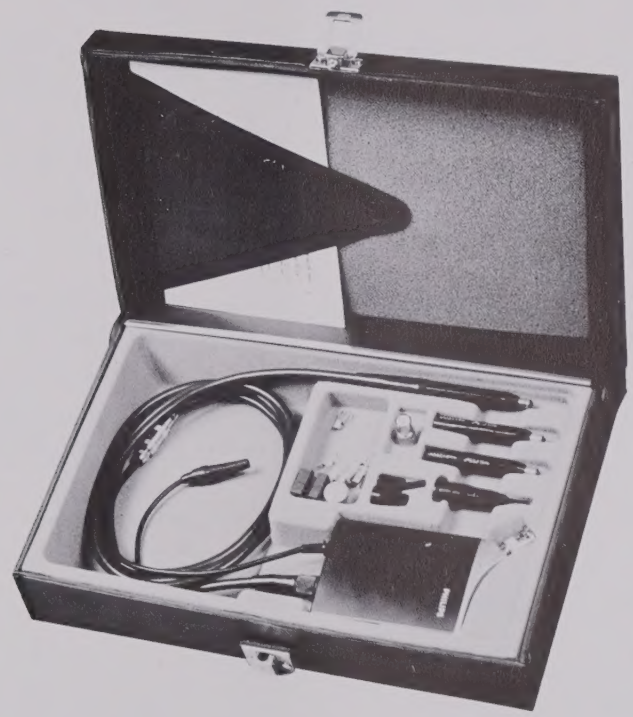

Fig. 1.1. FET Probe PM 9353

1.2. TECHNICAL DATA

Electrical characteristic		Specified performance	Additional information
1.2.1.	Gain	1x ±1 %	Probe connected to 1 MOhm oscilloscope input; after adjustment
1.2.2.	Input resistance	1 MOhm ±2 %	Same in D.C. and A.C. position
	Input capacitance	3.5 pF	Measured at 100 MHz
	Input impedance at h.f.	See Fig. 1.2.	
1.2.3.	Rise time	≤ 1.6 ns	Probe only
1.2.4.	Equivalent bandwidth	d.c. to ≥ 220 MHz (-3dB)	Switch in position D.C.
		3 Hz to ≥ 220 MHz (-3dB)	Switch in position A.C.
1.2.5.	Dynamic range	See Fig. 1.3.	
	Compression at limits of dynamic range	$0.99 \leq V_o/V_i \leq 1.00$	d.c. - 100 MHz
		$0.95 \leq V_o/V_i \leq 1.00$	> 100 MHz
1.2.6.	Offset voltage range	±1 V	
1.2.7.	Aberrations (rounding, tilt, overshoot and ringing)	Not exceeding ±2 %	Probe only; measured with 1 ns rise-time pulse on 50 MHz oscilloscope
		Not exceeding ±3 %	Probe only; measured with 1 ns rise-time pulse on 150 MHz oscilloscope
		Not exceeding ±5 %	Probe with 10x or 100x attenuator
1.2.8.	D.C. Drift		
	Probe tip assy + amplifier	≤ 0.3 mV/°C	
	Probe tip assy only	negligible	
1.2.9.	Signal delay time	10 ns ± 0.5 ns	
1.2.10.	Compensation range	14 to 21 pF	Input capacitance of oscilloscope, that can be compensated for
1.2.11.	Noise	< 0.5 mV	Tangentially measured on a 150 MHz oscilloscope
1.2.12.	Max. allowable input voltage d.c. + a.c. peak		
	(up to 0.1 MHz)	±100 V	
	For derating of a.c. component ≥ 0.1 MHz	See Fig. 1.4.	
	Non-repetitive	±200 V	During 1s at maximum
1.2.13.	Probe power requirements	+24 V at 32 mA	
		-24 V at 40 mA	
1.2.14.	10x Attenuator		
	Attenuation	10x ±3 %	Probe + attenuator
	Input resistance	1 MOhm ±2 %	
	Input capacitance	2.5 pF	
	Max. input voltage	±200 V	d.c. + a.c. peak

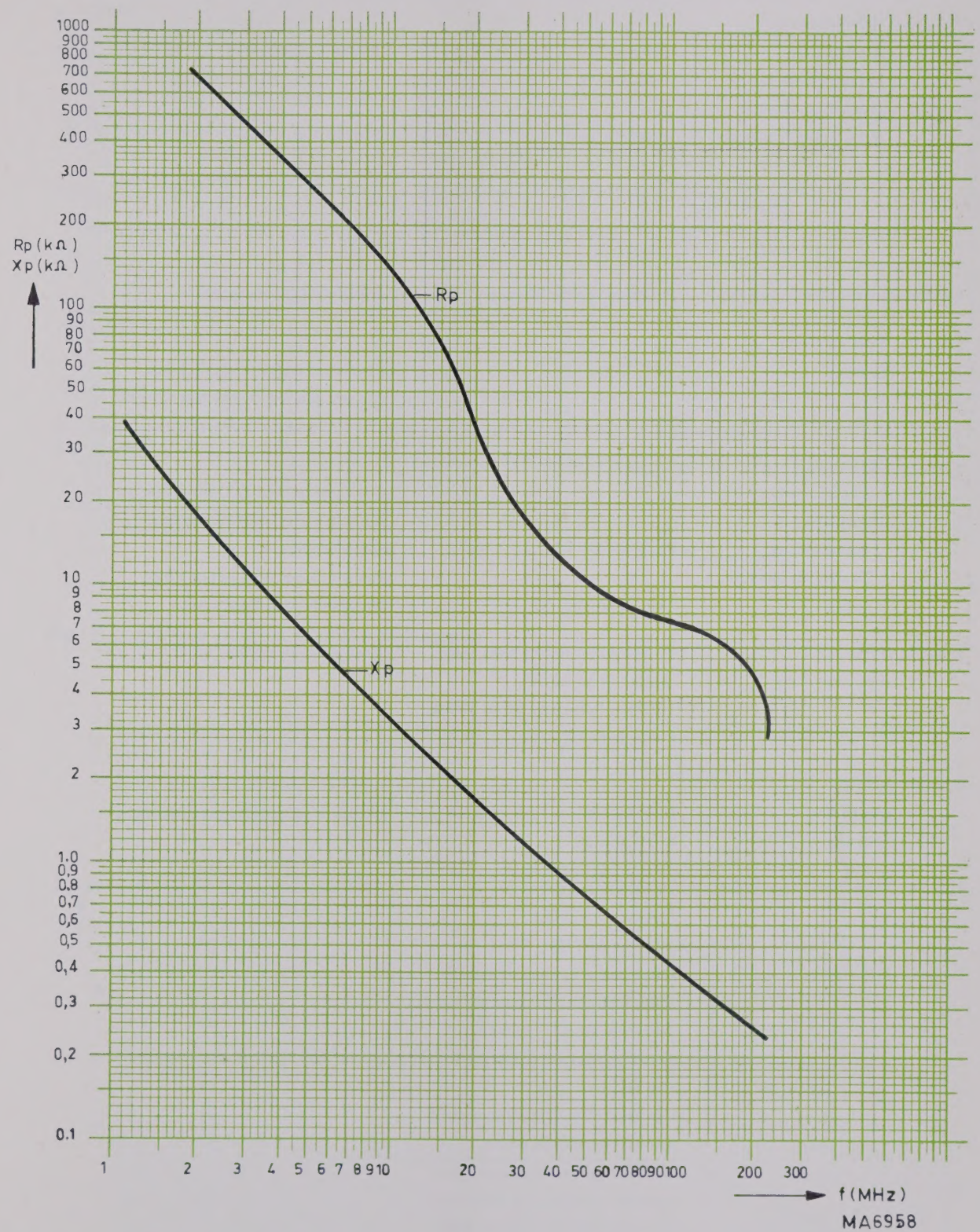

Fig. 1.2. Input resistance R_p and reactance X_p as functions of frequency

Electrical characteristic	Specified performance	Additional information
1.2.15. 100x Attenuator		
Attenuation	100x ±3 %	Probe + attenuator
Input resistance	1 MOhm ±2 %	
Input capacitance	1.5 pF	
Max. input voltage	±200 V	d.c. + a.c. peak

Environmental characteristic	Specified performance	Additional information
1.2.16. Temperature		
Storage	-40 °C to +70 °C	Test procedure IEC 68 tests Ab and Bb; recovery time from -40 °C to room temperature 1 hour
Operating		
Probe tip assy + amplifier + accessories	0 °C to +55 °C	Test procedure IEC 68 tests Ab and Bb; within electrical specification
Probe tip assy + cable	-10 °C to +55 °C	Specified requirements after occasional readjustment
1.2.17. Humidity, non-operating	21 cycles of damp heat test; temp. 25 to 40 °C; relative humidity 90 to 100 %; cycle time 24 hours	Test procedure IEC 50 B (CO) 142
1.2.18. Alitude		
Operating	to 5,000 m	Within electrical specification
Storage	to 15,000 m	
1.2.19. Vibration, operating	30 minutes each axis; frequency varied 10 Hz - 150 Hz - 10 Hz in ten-minute cycles; constant displacement 0.7 mm p-p from 10 Hz to 60 Hz; constant acceleration 5 g from 60 Hz to 150 Hz. Further 10 minutes each axis at any resonance point. Attachment to vibration platform by means of a BNC connector at one end and a mini connector at the other end	Test procedure IEC 68 test F

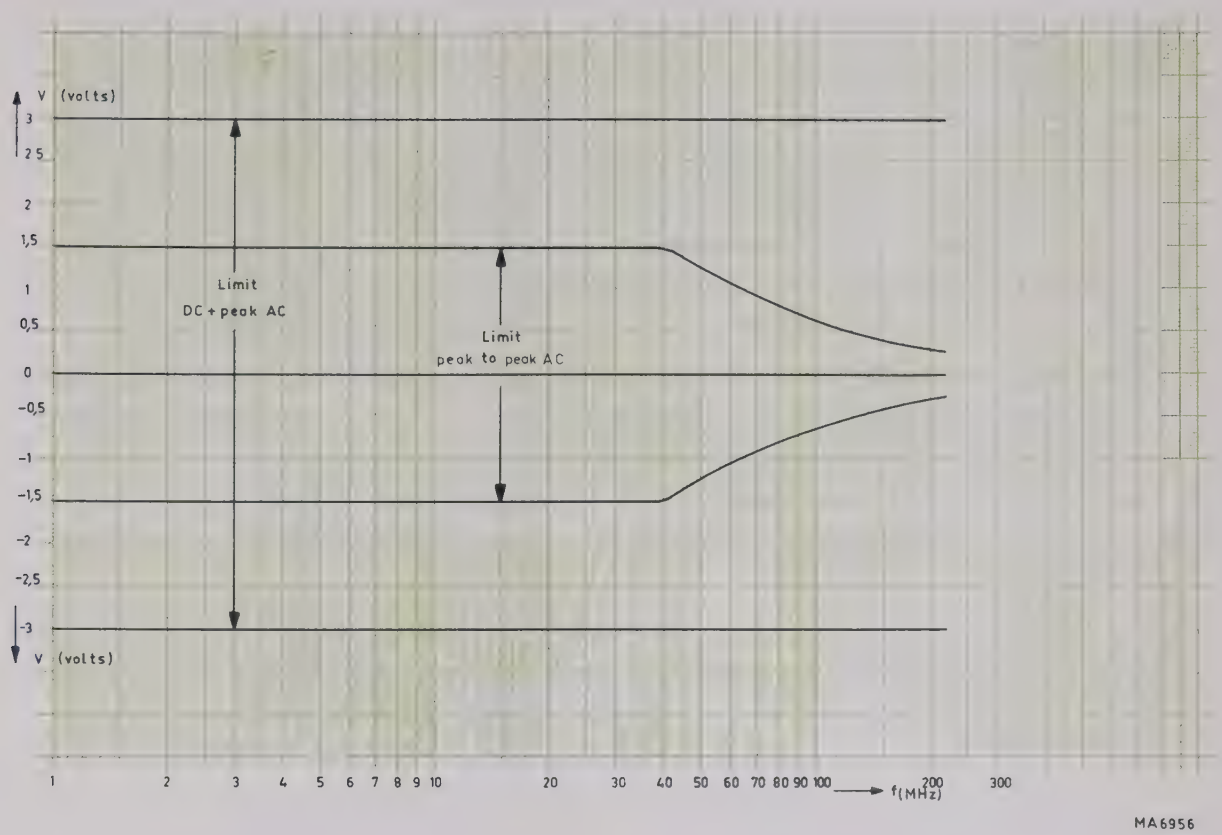

Fig. 1.3. Dynamic range as a function of frequency

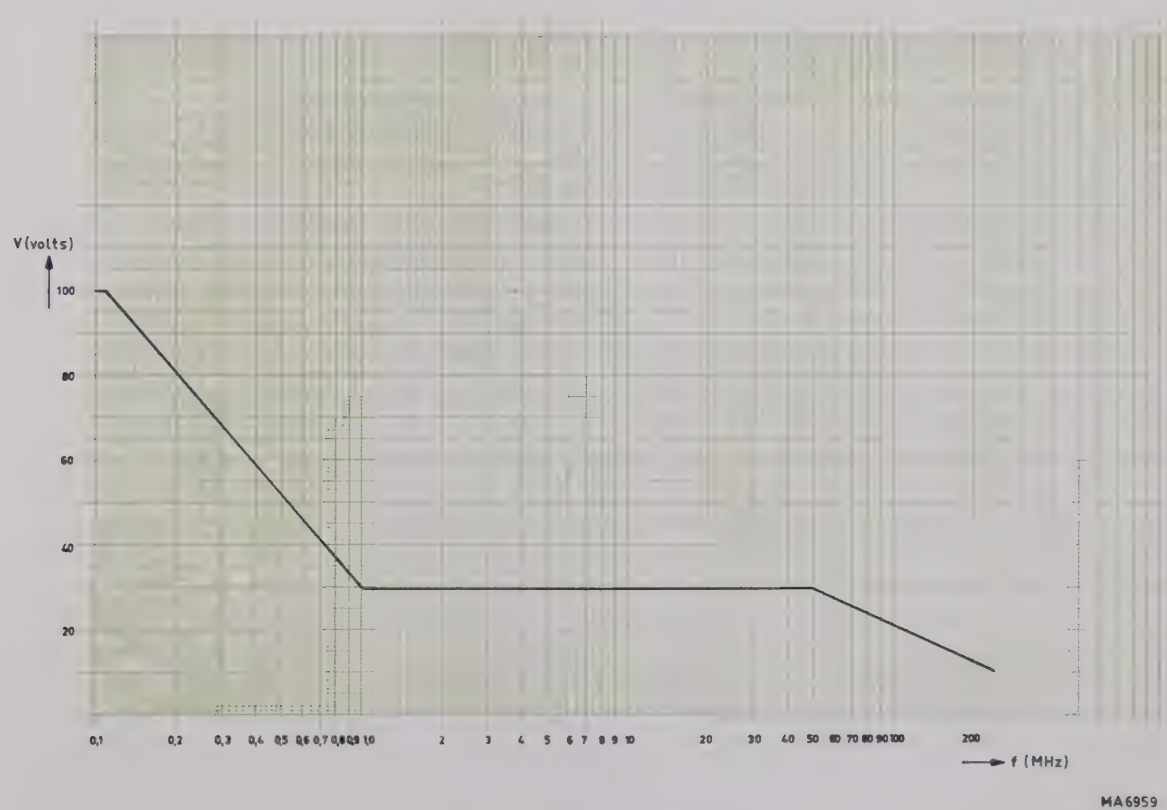

Fig. 1.4. Max. input voltage ($\pm$ V_{peak}) as a function of frequency

Environmental characteristic	Specified performance	Additional information
1.2.20. Shock, non-operating	Probe withstands 1,000 bumps each axis of half sine waves with a peak acceleration of 10 g. Attachment to shock platform by means of BNC connector at one end and a mini connector at the other end	Test procedure IEC 50 A (CO) 110
1.2.21. Transport		
Package drop	1 m on each corner and each flat surface, 12 drops in total	
Package toppling	10 minutes each axis at a frequency of 7 Hz and an amplitude of 7 mm.	

Mechanical characteristic	Specified quantity				Additional information
1.2.22. Dimensions	L	W	H		
Probe tip assy	100	10		mm	
Compensation box	80	63	22	mm	+ BNC connector
Test cable	1500			mm	from compensation box to probe tip
Power cable	220			mm	
Attenuators	60	10		mm	
Carrying case	280	185	42	mm	
1.2.23. Weight	700 gr				Probe in carrying case inclusive accessories
	1,100 gr				Shipping

1.3. STANDARD ACCESSORIES

1	Attenuator 10:1
1	Attenuator 100:1
1	Test hook
1	Adjustable earthing attachment
1	Earthing cord
1	Adapter to BNC & N connectors
2	Mini connectors
5	Soldering terminals
5	Earthing clips
1	Shorting cap (BNC)
2	Spare sleeves for test hook
4	Spare attenuator tips
1	Spare probe tip
1	Probe holder
1	Carrying case with insert
1	Manual
1	Short-form manual

2. DIRECTIONS FOR USE

2.1. GENERAL

Make sure that the input impedance of the oscilloscope you intend to use with the FET probe lies within the compensation range of the latter:
1 MOhm in parallel with 14 to 21 pF.

If the oscilloscope to be used is not provided with a probe power outlet, auxiliary power supply PM 9346 may be used.

2.2. SETTING UP PROCEDURE

Connect the FET probe to its oscilloscope as follows:
- Couple the BNC connector of the probe with the input socket of the oscilloscope
- Insert the power supply plug into the PROBE POWER socket of the oscilloscope (or connect it to the auxiliary power supply)

2.3. OFFSET AND COMPENSATION ADJUSTMENTS

The following adjustments must be made in order to ensure accurate operation of the probe:
- Set the AC/DC switch of the oscilloscope to position 0
- Display a time-base line and shift it to a convenient place on the screen as a zero reference
- Set the Y deflection coefficient of the oscilloscope to 0.5 V/div
- Set the AC/DC switch of the oscilloscope to position DC
- Check that it is possible to shift the time-base line to 2 div above and below the zero position, using OFFSET control R33
- Shift the time-base line to the exact zero position, using OFFSET control R33; increasing the Y sensitivity of the oscilloscope may facilitate this adjustment

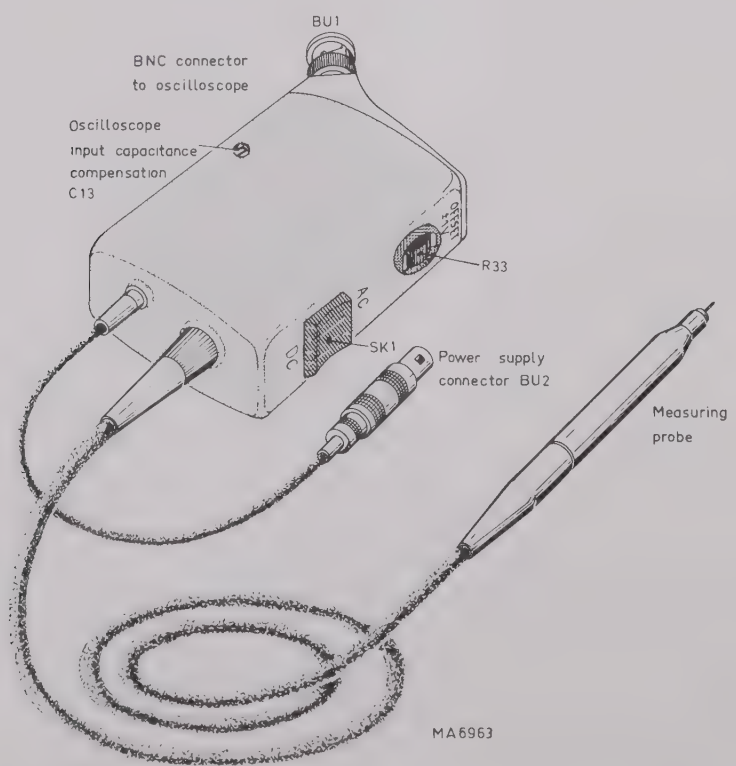

Fig. 2.1. Controls and sockets

- Set the AC/DC switch in the amplifier box of the probe to position DC
- Apply a square-wave signal with an amplitude within the dynamic range of the probe, a frequency of 2 kHz or higher and a rise time of at least 10 ns to the tip of the probe
- Set the oscilloscope for a trace height of 4 div
- Adjust trimmer C13 for optimum square-wave response.
  Trimmer C13 is accessible through an opening in the amplifier box.

2.4. MEASUREMENTS

During the measurements, the limitations of the probe as regards dynamic range (Fig. 1.3.) and voltage derating as a function of frequency (Fig. 1.4.) should be borne in mind.
Normally, the measurements are restricted to + and -1 V with respect to earth. These limits are extended by a factor 10 or 100, when the slip-on attenuators are used.

As d.c. voltages up to + or -1 V can be compensated for using OFFSET control R33, it is possible to obtain a display in the screen centre of a ripple voltage superimposed on + or -1 V, without switching over to a.c. coupling. It is self-evident that the control range of R33 will be 10 or 100 times as large, when the slip-on attenuators are used. The ripple, of course, will be attenuated by a factor 10 or 100 in that case.

If the probe is to be used for a.c. measurements, it is advisable to set the OFFSET control to its zero position (approximately mid-range) before switching over to a.c. coupling. This prevents the trace from disappearing when the coupling switch is set back to d.c. coupling.
For a.c. measurements, the AC/DC switch of the PROBE must be set to position AC and that of the oscilloscope to position DC.

2.5. INFORMATION ON ACCESSORIES

2.5.1. Attenuator 10:1 (Fig. 2.2. item 1)

This slip-on attenuator increases the dynamic range of the probe by a factor 10. The attenuator and the probe are joined by means of a plug and socket connection.

2.5.2. Attenuator 100:1 (Fig. 2.2. item 2)

This slip-on attenuator increases the dynamic range of the probe by a factor 100. The attenuator and the probe are joined by means of a plug and socket connection.

2.5.3. Test hook (Fig. 2.2. item 3)

The test hook can be slid over the probe. By pushing the probe deeper in the test hook, the hook will protrude so that the test point can be gripped.

2.5.4. Adjustable earthing attachment (Fig. 2.2. item 4)

This attachment facilitates short signal and earth connections.

2.5.5. Earth lead (Fig. 2.2. item 5)

The fork of the earth lead is pushed on to the metal part of the probe tip. The crocodile clip is connected to the earthing point of the circuit under test.

2.5.6. Adapter for BNC and N connectors (Fig. 2.2. item 6)

This adapter allows direct connection of the probe to a BNC or N connector. This adapter obviates the use of the earth lead.

2.5.7. Mini-connector (Fig. 2.2. item 7)

These mini-connectors may be incorporated into a circuit as routine test points. Earthing the outer shell of the mini-connector obviates the use of the earth lead.

2.5.8. Soldering terminals (Fig. 2.2. item 8)

When there is no place to use the test hook, you can solder these terminals in the circuit. The pin of the probe tip fits in these terminals. They must not be soldered on to the tip of the probe.

2.5.9. Earthing clips (Fig. 2.2. item 9)

These clips can be used together with the soldering terminals to provide a measuring earth, and support for the probe.

2.5.10. Shorting cap (Fig. 2.2. item 10)

This cap is needed to short-circuit the BNC connector of the probe during certain checks and adjustments. See also 3.3.1.

2.5.11. Spare sleeve for test hook (Fig. 2.2. item 11)

These test hook sleeves are supplied with the probe, to serve as replacement for damaged parts. See also 3.2.5.

2.5.12. Spare tips for probe and attenuators (Fig. 2.2. items 12 and 13)

These tips are supplied with the probe, to serve as replacements for damaged parts. See also 3.2.1. and 3.2.4.

2.5.13. Probe holder (Fig. 2.2. item 14)

The probe holder is pushed over the probe cable, close to the amplifier box. During a break in the measurements the probe cable close to the probe body can be pushed into the vacant slit of the probe holder.

The probe holder can also be used to take the weight off the probe when it is permanently connected to a circuit (Fig. 2.3.).

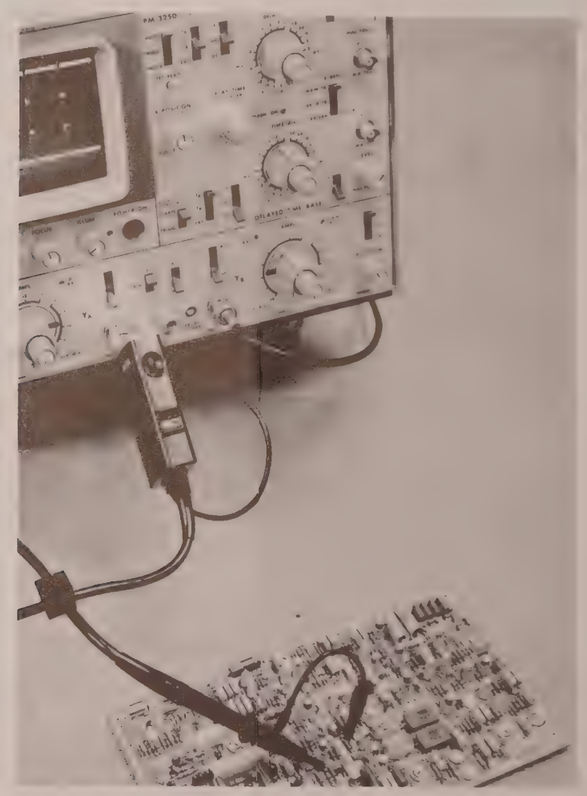

Fig. 2.3. Use of the probe holder

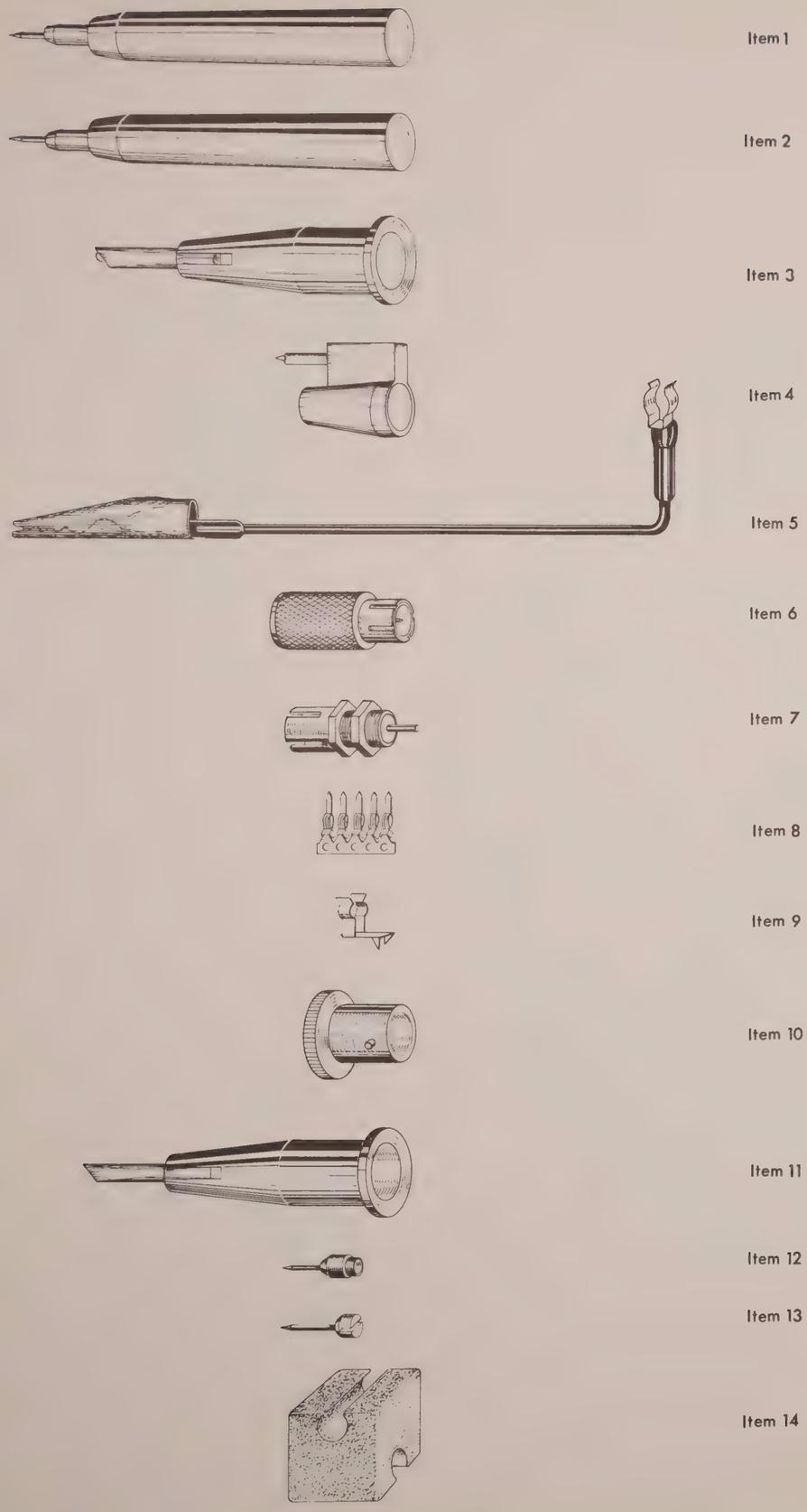

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Fig. 2.2. Accessories

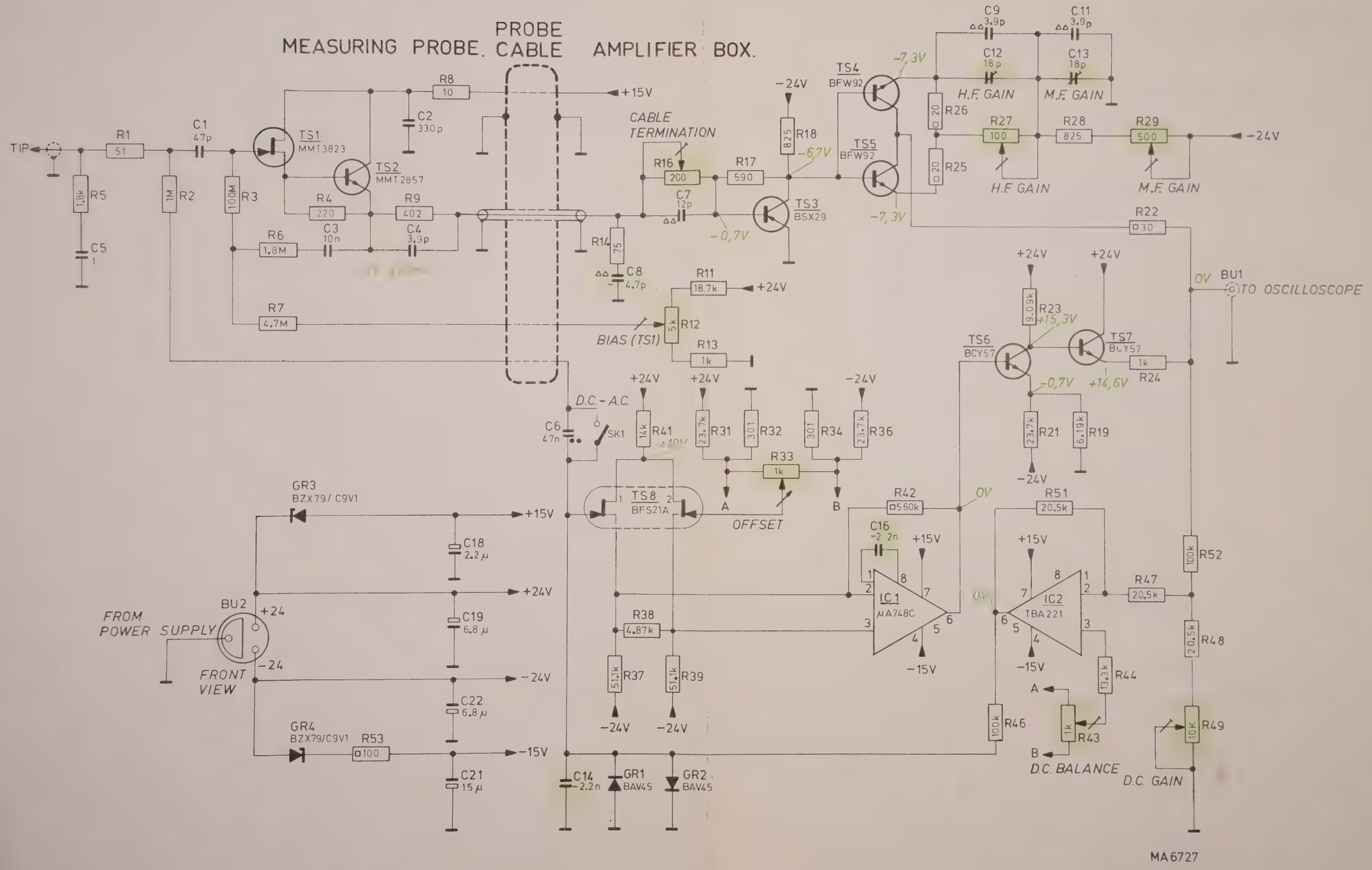

Fig. 3.1. Circuit diagram

3. SERVICE DATA

3.1. CIRCUIT DESCRIPTION (Fig. 3.1.)

3.1.1. General

The a.c. and d.c. components of the signal to be measured are separated and guided along different paths through the split-band amplifier shown in Fig. 3.2.

3.1.2. D.C. Path

The d.c. component of signal E_i enters the amplifier box via resistor R2 (1 MOhm) and causes a voltage drop across R46 (100 kOhm) of $\frac{R46}{R2 + R46} E_i = \frac{1}{11} E_i$.

The output signal E_o is attenuated by resistor R52 (100 kOhm), and the parallel connection R_v (24.2 kOhm) and R47 (20.5 kOhm). The attenuated signal is $\frac{Rv//R47}{(Rv//R47) + R52} E_o = \frac{1}{10} E_o$. This signal is fed to inverting amplifier IC2 which has a gain of C = -1, and from there via voltage divider R46-R2 to the input of source follower TS8. The input signal of TS8 is, thus,
$\frac{1}{11} E_i + (\frac{1}{10} E_o \cdot -1 \cdot \frac{R2}{R2 + R46}) = \frac{1}{11} E_i - \frac{1}{11} E_o$.

This signal is further amplified by stages IC1 with a gain A = -2 . 10^3 and TS6 with a gain B = -2. Thus, the output voltage of the probe E_o is

$-A \cdot -B \cdot (\frac{1}{11} E_i - \frac{1}{11} E_o) = \frac{1}{11} A \cdot B \cdot E_i - \frac{1}{11} A \cdot B \cdot E_o$.

$E_o (1 + \frac{1}{11} AB) = \frac{1}{11} AB E_i$

$\frac{E_o}{E_i} = \frac{\frac{AB}{11}}{1 + \frac{AB}{11}} = \frac{1}{1 + \frac{11}{AB}}$ $\qquad \frac{11}{AB} \ll 1$ thus $\frac{E_o}{E_i} \approx 1 - \frac{11}{AB}$

As we want the overall gain to be 1, $-\frac{11}{AB}$ represents an error. This error is $\frac{11}{AB} = \frac{11}{4000}$ or in percents $\frac{11}{4000} \cdot 100\ \% = 0.275\ \%$. This error can be eliminated by adjusting D.C. GAIN potentiometer R49, which is part of resistance R_v, to a suitable value.

3.1.3. A.C. Path

The a.c. component of the input signal is, via source follower TS1 and emitter follower TS2, fed to the amplifier box. The cable between the probe and the amplifier box consists of two coaxial conductors forming a 75 Ohm transmission line, and four accessory wires.
The transmission line is terminated in its characteristic impedance which is represented by the input impedance of transistor TS3 and CABLE TERMINATION potentiometer R16.
If CABLE TERMINATION potentiometer R16 is properly adjusted, there are no reflections in the transmission line.
The influence of the inductive part of the input impedance of transistor TS3 is compensated for by the series circuit of resistor R14 and capacitor C8.
From the transmission line the signal is fed to transistor TS3 where it is amplified to such an extent that it almost equals the input signal, and where its phase is inverted. The parallel transistors TS4 and TS5 amplify the signal to the same value as the input signal and invert its phase again. Therefore, the output signal equals the input signal in amplitude as well as in phase. The gain is adjusted for h.f. signals by means of H.F. GAIN trimmer C12 and potentiometer R27, and for m.f. signals by means of M.F. GAIN trimmer C13 and potentiometer R29.

3.1.4. General circuitry

The offset voltage of integrated circuit IC2 is compensated for by the correct setting of D.C. BALANCE potentiometer R43.
Diodes GR1 and GR2 protect the input of one field-effect transistor of TS8 from damage by over-voltages. The d.c. voltage at the other input of TS8 can be varied by OFFSET potentiometer R33 to compensate for some d.c. voltage at the input of the probe.

The d.c. bias for field-effect transistor TS1 can be adjusted by means of potentiometer BIAS (TS1) R12.
D.C. Signals can be isolated from the probe by setting D.C./A.C. switch SK1 to position A.C. The d.c. path is then blocked.

3.1.5. 10:1 Attenuator (Fig. 3.3)

The resistive voltage divider consists of R54 (900 kOhm) and R56 (111 kOhm). Resistor R56 shunts the input resistance of the probe (1 MOhm) so that the equivalent resistance Rv is approximately 100 kOhm. Resistance Rv together with resistor R54 gives the probe its input resistance of 1 MOhm and its attenuation factor of 10x.

The attenuation factor is made independent of frequency by adjusting trimmer C24 in such a way that RC time R54 . C23 equals RC time $R56//R_{i\ probe} \cdot C24+C_{i\ probe}$.

3.1.6. 100:1 Attenuator (Fig. 3.4)

This attenuator is basically the same as the 10:1 attenuator. The resistive voltage divider consists of resistors R57, R58 and $R_{i\ probe}$. The capacitive part consists of capacitors C26, C27, C28 and $C_{i\ probe}$.

3.2. DISMANTLING AND REPLACING PARTS

3.2.1. Probe body

The printed-wiring board in the probe body is accessible after unscrewing the shell.
BE CAREFUL NOT TO BEND THE PRINTED-WIRING BOARD as this may result in exerting undue stresses on the chip type resistors (R1, R5) and capacitors (C1, C2, C3, C4, C5).

The chips are fitted with silver-plated ends as connecting terminals. Using ordinary 60/40 Sn/Pb solder may cause migration of the silver from the silver-plated terminals into the solder; this results in a loss of bond strength. Therefore, a solder containing silver should be used (see Parts List 3.4.1.).

When replacing a chip, the following points should be observed:
- The soldering iron temperatures are often well above the melting point of the solder. If the chips are kept immersed for too long a period in the molten solder, the silver plating may migrate in any event.
- Corners and edges of the chips could be damaged by the use of metal tweezers; therefore, plastic ones should be used.

When the tip of the probe has been broken, it can be replaced by soldering the spare one on to the printed-wiring board.

3.2.2. Probe cable

Loose or broken soldering connections can be soldered.
We do not encourage further cable repairs and advise to replace the whole cable.

3.2.3. Amplifier box

The cover of the amplifier box can be withdrawn after unscrewing the knurled nut of the cable. Service work in the amplifier is easy if light tools are used.

To replace the sliding knob of the D.C./A.C. switch the three parts: sliding knob, actuating spring and clamping spring must be pushed out of the box. The new knob can be forced home by pushing the three combined parts into the square hole, with the hammer of the actuating spring in the direction of the open end of the box. The cover must always be refitted with the D.C./A.C. switch in position D.C. It may sometimes be necessary to pull the supply cable during the refitting of the cover.

3.2.4. Attenuators

A damaged tip can be pulled out by means of a pair of pliers. A new one must be firmly pushed in. We do not encourage any further repairs as assembling the attenuators requires special tools and we advise to replace the whole attenuator.

3.2.5. Test hook

If the sleeve of the test hook is damaged, it can be pulled off whilst the hooks of the inner part are pushed in. A spare test-hook sleeve can then easily be pushed over the inner part. The wire hook should be inserted in such a way that the opening is formed by its tip and the longer side of the sleeve.

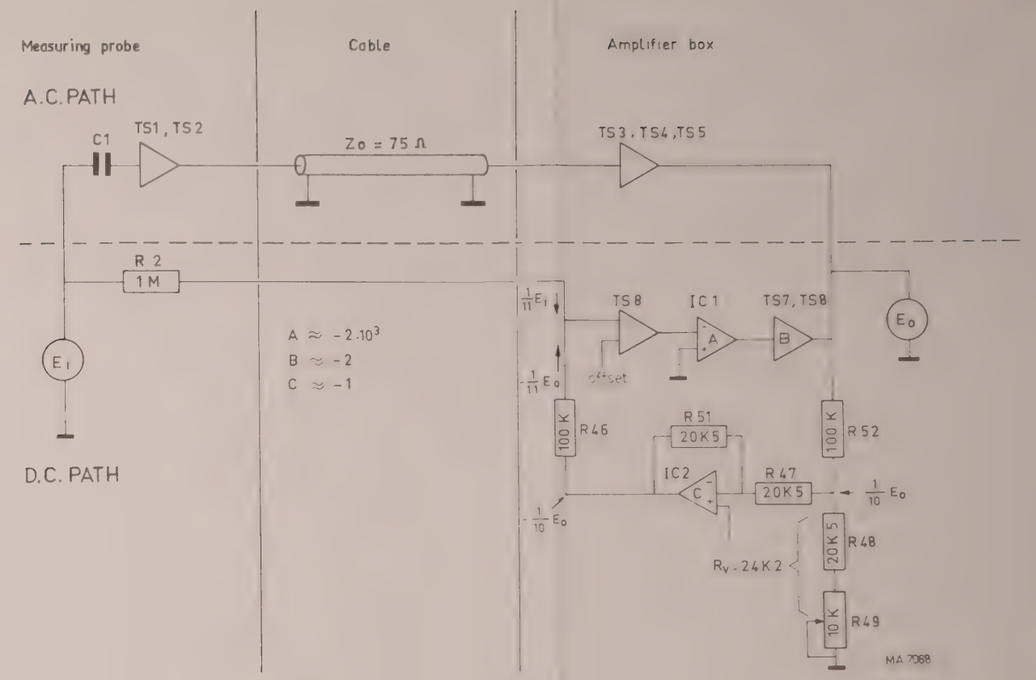

Fig. 3.2. Simplified diagram

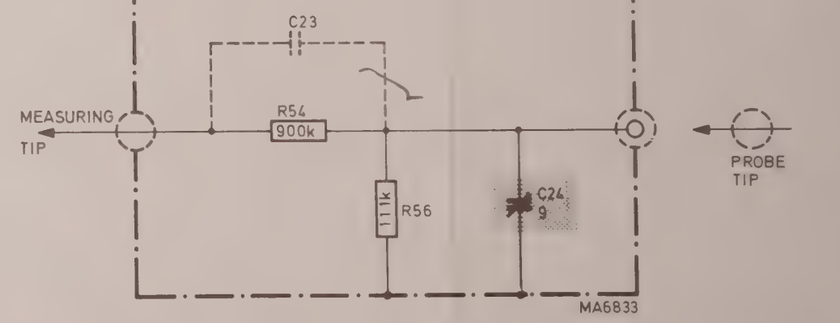

Fig. 3.3. Diagram 10:1 attenuator

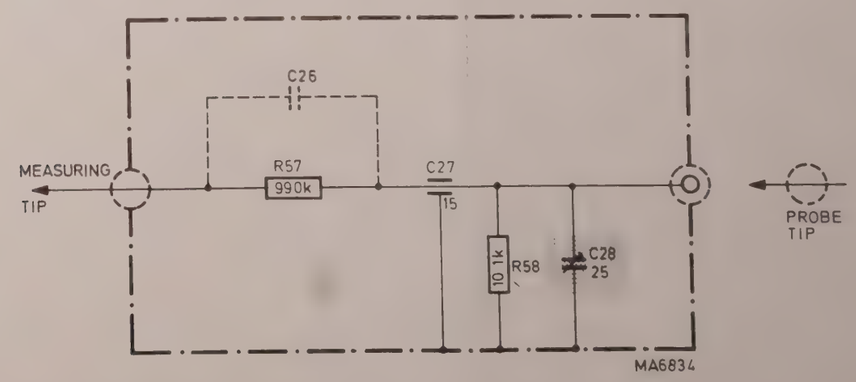

Fig. 3.4. Diagram 100:1 attenuator

3.3. CHECKING AND ADJUSTING

3.3.1. Preliminary adjustments (R12, R43)

- Remove the probe shell and the cover of the amplifier box.
- Turn potentiometer R12 anti-clockwise
- Set potentiometer R16 to mid-position
- Apply the 24 V supply voltage
- Bias field-effect transistor TS1 by means of potentiometer R12 in such a way, that the emitter voltage of transistor TS2 (point A in Fig. 3.5.) is +4 V + or -0.1 V.

BE CAREFUL NOT TO BEND OR WARP THE PRINTED-WIRING BOARD OF THE PROBE.

- Fit the probe shell
- Short-circuit BNC socket BU1 by means of the accessory shorting cap
- Adjust the voltage at junction R46-R51 (point B in Fig. 3.6.) to 0 V + or -5 mV, by means of potentiometer R43.
- Remove the shorting cap

3.3.2. D.C. Gain (R49)

- Set the oscilloscope for a free-running time base
- Centre the time-base line
- Connect the BNC connector of the amplifier box to the input of the oscilloscope
- Check that it is possible to shift the time-base line over a distance equivalent to a value between 1 and 1.5 V in upward and downward direction, using potentiometer R33
- Adjust the time-base line to within 5 mV of its original position in the centre of the screen, using potentiometer R33
- Apply a voltage of 1 V + or -10 mV to the probe tip and adjust potentiometer R49 for a voltage of 1 V + or -10 mV at connector BU1

3.3.3. M.F. Gain and cable termination (C13, R16, R29)

- Apply a square-wave voltage with a rise time of 1 ns, a duration of 100 ns, a repetition frequency of 100 kHz and an amplitude of 1 V, to the tip of the probe.
  Use a 50 Ohm termination pad.
- Adjust potentiometer R29 to obtain a trace height equivalent to 1 V
- Minimize aberrations due to reflections, using potentiometer R16 (see Figs. 3.8. & 3.9.)
- Adjust trimmer C13 for a flat pulse top (see Fig. 3.8.)

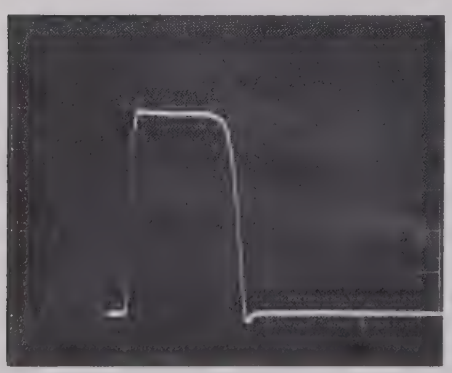

Fig. 3.8. C13, R16 and R29 correctly adjusted

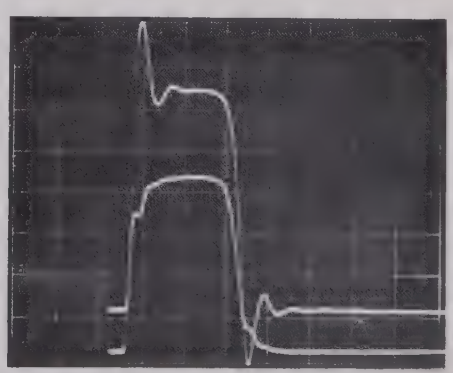

Fig. 3.9. R16 incorrectly adjusted

3.3.4. L.F. Response (R29, C14, C16)

- Apply a square-wave voltage with a rise time of 10 ns, a duration of $\frac{1}{2}$T, a repetition frequency of 100 Hz and an amplitude of 1 V, to the tip of the probe.
  Use a 50 Ohm termination pad.
- Readjust potentiometer R29 for a flat pulse top
- Fit a plate-type ceramic capacitor C14 of approximately 2.2 nF (100 V, 10 %)
- Select a similar capacitor for C16 with such a value between 1 nF and 4.7 nF, that a square transition from top to leading edge is obtained; see also Fig. 3.10.
  If no satisfactory result can be obtained, select a different value for C14.

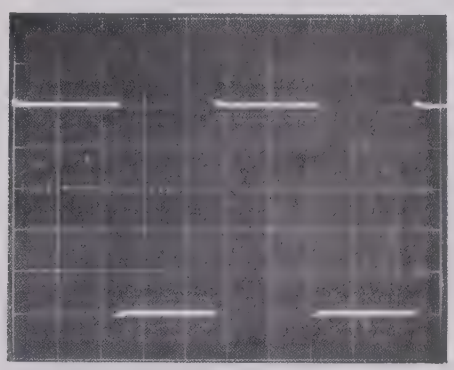

Fig. 3.10. C14 and C16 incorrectly adjusted

3.3.5. H.F. Gain (C8, C12, C13, R27)

- Connect BNC connector BU1 to a 150 MHz oscilloscope
- Apply a square-wave voltage with a rise time of 1 ns, duration 100 ns, repetition frequency 100 kHz and an amplitude 0.1 V, to the tip of the probe.
  Use a 50 Ohm termination pad.
- Readjust trimmer C13 for a flat pulse top
- Adjust potentiometer R27 for the steepest possible leading edge
- Minimize aberrations due to reflections by adjusting trimmer C12 and selecting a suitable value between 3.9 and 6.8 pF for capacitor C8 (see Fig. 3.11.)

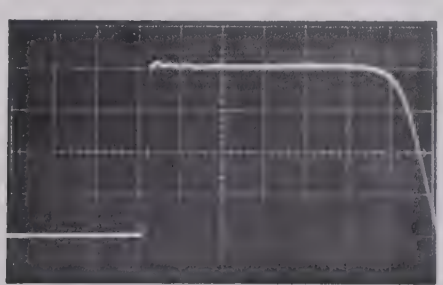

Fig. 3.11. C8, C12, C13 and R27 correctly adjusted

3.3.6. AC/DC Switch

- Set the AC/DC switch to DC
- Apply a 10 Hz square-wave voltage to the tip of the probe
- Adjust trimmer C13 for optimum square-wave response (see Fig. 3.12. top)
- Set the AC/DC switch to AC
- Check that the waveform shows droop as in Fig. 3.12. bottom.

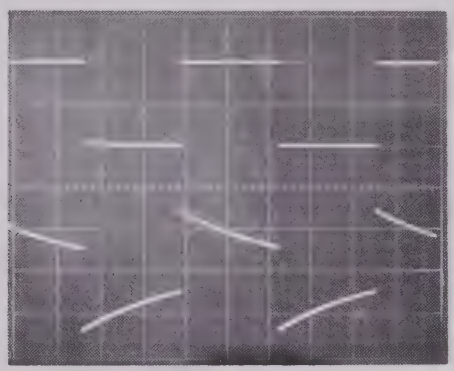

Fig. 3.12. Display of a 10 Hz signal with the AC/DC switch in position DC (top) and AC (bottom)

3.3.7. 10x Attenuator (C24)

- Check that the resistance between the attenuator tip and the shell is 1011 kOhm + or -1 %. Note that the attenuator is not plugged on to the probe tip.
- Connect the probe to a suitable oscilloscope, e.g. PM 3370 + PM 3372 and calibrate the Y deflection with the aid of a 40 mV square-wave signal at a frequency of 2 kHz. If necessary, readjust trimmer C13.
- Slide the x10 attenuator over the probe tip
- Apply a square-wave voltage of 400 mV_{p-p} at a frequency of 2 kHz or higher and a rise time of at least 10 ns to the attenuator tip
- Check that the trace height is the same as after calibration without the attenuator; tolerance + or -3 %
- Apply a square-wave voltage with a rise time of 1 ns, a pulse width of 100 ns, a repetition frequency of 100 kHz and an amplitude of 500 mV_{p-p} to the tip of the attenuator and check that the overshoot and ringing are less than 5 % (see Fig. 3.13.); if necessary, adjust trimmer C24 (accessible through a hole in the attenuator shell).

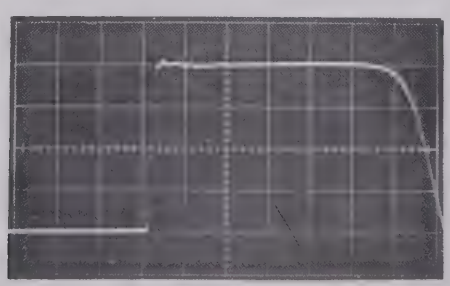

Fig. 3.13. C24 correctly adjusted

3.3.8. 100x Attenuator (C28)

- Check that the resistance between the attenuator tip and the shell is 1000.1 kOhm + or -1 %
- Check that the resistance between the attenuator output and the shell is 10.1 kOhm + or -1 %
- Connect the probe to a suitable oscilloscope, e.g. PM 3370 + PM 3372 and calibrate the Y deflection with the aid of a 40 mV square-wave signal at a frequency of 2 kHz. If necessary, readjust trimmer C13.
- Slide the x100 attenuator over the probe tip
- Apply a square-wave voltage of 4 V_{p-p} at a frequency of 2 kHz or higher and a rise time of at least 10 ns to the attenuator tip
- Check that the trace height is the same as after calibration without the attenuator; tolerance + or -3 %
- Apply a square-wave voltage with a rise time of 1 ns, a pulse width of 100 ns, a repetition frequency of 100 kHz and an amplitude of 5 V_{p-p} to the tip of the attenuator and check that the overshoot and ringing are less than 5 % (see Fig. 3.14.); if necessary, adjust trimmer C28 (accessible through a hole in the attenuator shell).

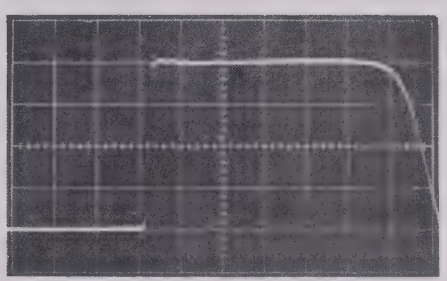

Fig. 3.14. C28 correctly adjusted

3.4. PARTS LISTS

3.4.1. Mechanical parts

Item	Fig.	Qty	Order number	Description
1	2.2.	1	5322 264 24002	10x Attenuator
2	2.2.	1	5322 264 24003	100x Attenuator
3	2.2.	1	5322 264 24004	Test hook
4	2.2.	1	5322 264 24005	Adjustable earthing attachment
5	2.2.	1	5322 321 24107	Earth lead
6	2.2.	1	5322 263 50022	Adapter to BNC & N connectors
7	2.2.	2	5322 267 10043	Mini-connector
8	2.2.	5	5322 255 44026	Soldering terminal
9	2.2.	5	5322 256 94024	Earthing clip
10	2.2.	1	5322 263 64003	Shorting cap BNC
11	2.2.	2	5322 264 24006	Spare sleeve for test hook
12	2.2.	4	5322 268 14017	Spare attenuator tip
13	2.2.	1	5322 268 14018	Spare probe tip
14	2.2.	1	5322 256 94034	Probe holder
15	-	1	5322 600 34001	Carrying case with insert
16	3.15.	1	5322 447 60041	Chromium-plated end piece
17	3.15.	1	5322 264 10043	BNC Connector assy
18	3.6.	1	5322 216 54059	Printed-wiring card with components Unit 2
19	3.15.	1	5322 447 64005	Cover for amplifier box
20	3.15.	1	5322 325 50097	Grommet
21	3.15.	1	5322 321 20248	Supply cable with plug
22	3.15.	1	5322 321 24106	Complete probe cable
23	3.15.	1	5322 414 64008	Sliding knob
24	3.15.	1	5322 492 64268	Actuating spring
25	3.15.	1	5322 492 64269	Clamping spring
26	3.5.	1	5322 216 54061	Printed-wiring card in probe Unit 1
27	3.15.	1	5322 447 64006	Probe shell
28	3.7.	1	5322 271 30078	Micro switch
29	-	100 g	5322 390 84001	Silver-containing solder (59 % tin, 34 % lead, 6 % silver, melting point 180 °C)

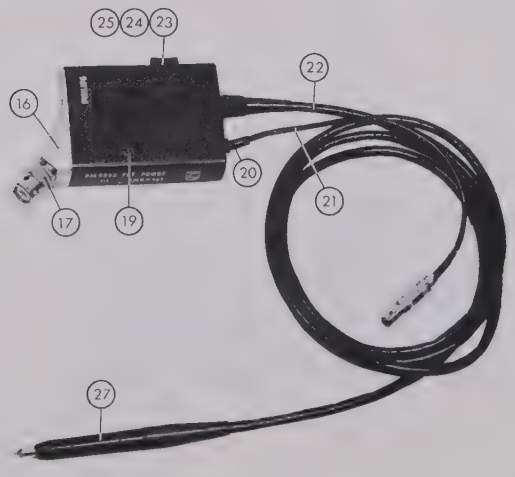

Fig. 3.15. Probe assy with item numbers

3.4.2. Electrical parts

This parts list does not contain multi-purpose and standard parts. These components are indicated in the circuit diagram by means of identification marks. The specification can be derived from the survey below.

Diese Ersatzteilliste enthält keine Universal- und Standard-Teile. Diese sind im jeweiligen Prinzipschaltbild mit Kennzeichnungen versehen. Die Spezifikation kann aus nachstehender Übersicht abgeleitet werden.

In deze stuklijst zijn geen universele en standaardonderdelen opgenomen. Deze componenten zijn in het principeschema met een merkteken aangegeven. De specificatie van deze merktekens is hieronder vermeld.

La présente liste ne contient pas des pièces universelles et standard. Celles-ci ont été repérées dans le schéma de principe. Leurs specifications sont indiquées ci-dessous.

Esta lista de componentes no comprende componentes universales ni standard. Estos componentes están provistos en el esquema de principio de una marca. El significado de estas marcas se indica a continuación.

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
} 0,125 W 5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 1 W ≦ 2,2 MΩ, 5%
> 2,2 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 0,25 W ≦ 1 MΩ, 5%
> 1 MΩ, 10%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 2 W 5%

Carbon resistor E24 series
Kohleschichtwiderstand, Reihe E24
Koolweerstand E24 reeks
Résistance au carbone, série E24
Resistencia de carbón, serie E24
} 0,5 W ≦ 5 MΩ, 1%
> 5 ≦ 10 MΩ, 2%
> 10 MΩ, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
} 0,4 – 1,8 W 0,5%

Carbon resistor E12 series
Kohleschichtwiderstand, Reihe E12
Koolweerstand E12 reeks
Résistance au carbone, série E12
Resistencia de carbón, serie E12
} 0,5 W ≦ 1,5MΩ, 5%
> 1,5MΩ, 10%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
} 5,5 W ≦ 200 Ω, 10%
> 200 Ω, 5%

Wire-wound resistor
Drahtwiderstand
Draadgewonden weerstand
Résistance bobinée
Resistencia bobinada
} 10 W 5%

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
} 500 V

Polyester capacitor
Polyesterkondensator
Polyesterkondensator
Condensateur au polyester
Condensador polyester
} 400 V

Tubular ceramic capacitor
Rohrkondensator
Keramische kondensator, buistype
Condensateur céramique tubulaire
Condensador cerámico tubular
} 700 V

Flat-foil polyester capacitor
Miniatur-Polyesterkondensator (flach)
Platte miniatuur polyesterkondensator
Condensateur au polyester, type plat
Condensador polyester, tipo de placas planas
} 250 V

Ceramic capacitor, "pin-up"
Keramikkondensator "Pin-up" (Perltyp)
Keramische kondensator "Pin-up" type
Condensateur céramique, type perle
Condensador cerámico, versión "colgable"
} 500 V

Paper capacitor
Papierkondensator
Papierkondensator
Condensateur au papier
Condensador de papel
} 1000 V

"Microplate" ceramic capacitor
Miniatur-Scheibenkondensator
"Microplate" keramische kondensator
Condensateur céramique "microplate"
Condensador cerámico "microplaca"
} 30 V

Wire-wound trimmer
Drahttrimmer
Draadgewonden trimmer
Trimmer à fil
Trimmer bobinado

Mica capacitor
Glimmerkondensator
Micakondensator
Condensateur au mica
Condensador de mica
} 500 V

Tubular ceramic trimmer
Rohrtrimmer
Buisvormige keramische trimmer
Trimmer céramique tubulaire
Trimmer cerámico tubular

For multi-purpose and standard parts, please see PHILIPS' Service Catalogue.
Für die Universal- und Standard-Teile siehe den PHILIPS Service-Katalog.
Voor universele en standaardonderdelen raadplege men de PHILIPS Service Catalogus.
Pour les pièces universelles et standard veuillez consulter le Catalogue Service PHILIPS.
Para piezas universales y standard consulte el Catálogo de Servicio PHILIPS.

3.4.2.1. Capacitors

Item	Order number	Value	Tol.	V	Description
C1	5322 122 34009	47 pF	5 %	200	Chip
C2	5322 122 34011	330 pF	10 %	50	Chip
C3	5322 122 34012	10 nF	10 %	50	Chip
C4	5322 122 34013	3.9 pF	5 %	100	Chip
C5	5322 122 34014	1 pF	5 %	200	Chip
C12	5322 125 50051	18 pF			Trimmer
C13	5322 125 50051	18 pF			Trimmer
C18	5322 124 10018	2.2 µF		20	Electrolytic
C19	5322 124 10073	6.8 µF		35	Electrolytic
C21	5322 124 10017	15 µF		20	Electrolytic
C22	5322 124 10073	6.8 µF		35	Electrolytic

3.4.2.2. Resistors

Item	Order number	Value	Tol.	W	Description
R1	5322 116 94004	51 Ω	5 %	0.1	Chip
R2	5322 116 54117	1 MΩ	1 %		Thick film
R3	5322 111 30376	100 MΩ	5 %	0.125	A.B.
R4	5322 111 44119	220 Ω	5 %	0.125	A.B.
R5	5322 116 94005	1.8 kΩ	5 %	0.1	Chip
R6	5322 111 44121	1.8 MΩ	5 %	0.125	A.B.
R7	5322 111 44122	4.7 MΩ	5 %	0.125	A.B.
R8	5322 111 44123	10 Ω	5 %	0.125	A.B.
R9	5322 116 54127	402 Ω	1 %		Thick film
R11	5322 116 50558	18.7 kΩ	1 %		Metal film
R12	5322 100 10139	5 kΩ	30 %		Helitrim potmeter
R13	5322 116 50573	1 kΩ	1 %		Metal film
R14	5322 111 44124	75 Ω	5 %		A.B.
R16	5322 100 10133	200 Ω	30 %		Helitrim potmeter
R17	5322 116 50561	590 Ω	1 %		Metal film
R18	5322 116 50978	825 Ω	1 %		Metal film
R19	5322 116 50608	6.19 kΩ	1 %		Metal film
R21	5322 116 50908	23.7 kΩ	1 %		Metal film
R23	5322 116 50537	9.09 kΩ	1 %		Metal film
R24	5322 116 51054	1 kΩ	1 %		Metal film
R27	5322 100 10138	100 Ω	30 %		Helitrim potmeter
R28	5322 116 50978	825 Ω	1 %		Metal film
R29	5322 100 10135	500 Ω	30 %		Helitrim potmeter
R31	5322 116 50908	23.7 kΩ	1 %		Metal film
R32	5322 116 50786	301 Ω	1 %		Metal film
R33	5322 101 94001	1 kΩ	20 %	0.1	Potentiometer
R34	5322 116 50786	301 Ω	1 %		Metal film
R36	5322 116 50908	23.7 kΩ	1 %		Metal film
R37	5322 116 50672	51.1 kΩ	1 %		Metal film
R38	5322 116 50509	4.87 kΩ	1 %		Metal film

Item	Order number	Value	Tol.	W	Description
R39	5322 116 50672	51.1 kΩ	1 %		Metal film
R41	5322 116 50864	14 kΩ	1 %		Metal film
R43	5322 100 10143	1 kΩ	30 %		Helitrim potmeter
R44	5322 116 50598	13.3 kΩ	1 %		Metal film
R46	5322 116 50244	100 kΩ	1 %		Metal film
R47	5322 116 50396	20.5 kΩ	1 %		Metal film
R48	5322 116 50396	20.5 kΩ	1 %		Metal film
R49	5322 100 10141	10 kΩ	30 %		Helitrim potmeter
R51	5322 116 50396	20.5 kΩ	1 %		Metal film
R52	5322 116 50244	100 kΩ	1 %		Metal film

3.4.2.3. Transistors

Item	Type	Order number
TS1	MMT3823	5322 130 44091
TS2	MMT2857	5322 130 44092
TS3	BSX29	5322 130 40205
TS4	BFW92	5322 130 40745
TS5	BFW92	5322 130 40745
TS6	BCY57	5322 130 40491
TS7	BCY57	5322 130 40491
TS8	BFS21A	5322 130 40709

3.4.2.4. Diodes

Item	Type	Order number
GR1	BAV45	5322 130 34037
GR2	BAV45	5322 130 34037
GR3	BZX79/C9V1	5322 130 30667
GR4	BZX79/C9V1	5322 130 30667

3.4.2.5. Integrated circuits

IC1	μA748C	5322 209 84113
IC2	TBA221	5322 209 84112

PHILIPS BUSINESS INSTRUMENTS INC.
A NORTH AMERICAN PHILIPS COMPANY
224 DUFFY AVENUE
HICKSVILLE, NEW YORK 11802